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Report From CART: "Neural Interactions Between the Small Intestine and the Sphincter of Oddi" And "Sustainable Development for Economic, Social, and Environmental Health"

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CENTER FOR THE ADVANCEMENT OF RESEARCH AND TEACHING

CART grants enable faculty and librarians to pursue research projects. "Neural Interactions Between the Small Intestine and the Sphincter of Oddi" and "Sustainable Development: The Search for Economic, Social, and Environmental Health" are among the projects which were recently awarded CART grants.

NEURAL INTERACTIONS BETWEEN THE SMALL INTESTINE AND THE SPHINCTER OF ODDI

*Audra Kennedy, Assistant Professor of
Biological Sciences*



My research involves a body part you may never have heard of, a small but important part of the digestive system called the sphincter of Oddi. The sphincter of Oddi is a small muscular cuff named after the 19th century Italian scientist, Ruggero Oddi, who first studied it. Located at the junction of the common bile duct and the intestine, it regulates the flow of bile from the gallbladder into the intestine. Bile helps us to digest fats; inflammation of the sphincter of Oddi can lead to formation of gallstones and prevent proper digestion. Improper functioning of the sphincter of Oddi has been shown to be a major contributor to biliary disease, which affects approximately 20 million Americans and

results in over 600,000 cholecystectomies (surgical removals of the gallbladder) each year.

How does the sphincter of Oddi know when to open and when to close? Although we know that the nervous system is involved, the exact mechanisms of its regulation are not entirely clear. As part of my doctoral dissertation research, completed in 1999 under Dr. Gary Mawe of the Department of Anatomy and Neurobiology at the University of Vermont College of Medicine, I examined the neural mechanisms by which the sphincter of Oddi is regulated. Working with guinea pigs, Dr. Mawe and I identified a neural connection linking a section of the small intestine called the duodenum with the sphincter of Oddi. Using a fluorescent dye that is transported along nerve fibers (called axons), we demonstrated that neurons located in the duodenum send axons to the sphincter of Oddi. Neurons work by releasing chemicals called neurotransmitters from their nerve endings. We expanded our studies of the neurons going to the sphincter of Oddi by determining what neurotransmitters they synthesize. Neurons in the enteric nervous system (the nervous system which controls the gastrointestinal tract) can be divided into separate groups on the basis of their chemical content. The technique of immunohistochemistry examines the neurons based on their coding patterns for different chemicals. As a result, scientists can determine the function of a given population of neurons based on the presence or absence of particular chemicals within the cell. Using immunohistochemical technique, we were able to determine the types of

duodenal neurons sending nerve fibers to the sphincter of Oddi. We determined that these neurons synthesize excitatory neurotransmitters, which cause the sphincter muscle to contract.

We performed additional electrophysiological studies to further examine this mechanism. These studies involved recording electrical activity from target neurons located within the sphincter of Oddi while stimulating axons passing into the sphincter from the duodenum. We demonstrated that the duodenal neurons sending projections to the sphincter of Oddi are capable of electrically activating neurons located within the sphincter. Activation of neurons in the sphincter of Oddi by neurons in the duodenum is likely to increase the contraction of this muscle, thus closing the bile duct pathway leading into the duodenum. Ultimately, it is likely to be demonstrated that the pathway we have identified is directly involved in the sphincter of Oddi's function. The reflex circuit is likely to play several roles in digestion, including (1) generating waves of sphincter of Oddi contraction and relaxation that allow bile to enter the duodenum, (2) notifying the sphincter of Oddi that food has entered the duodenum and that bile should be delivered to aid in digestion, and (3) limiting the entry of digested food from the intestine into the bile duct during periods of gut peristalsis or vomiting.

The CART grant I have received will enable me to return to Dr. Mawe's laboratory as a visiting researcher this summer to continue to explore the role that the nervous system plays in the functioning of the sphincter of Oddi. Having established the working hypothesis that extensive communication between neurons in the duodenum and neurons in the sphincter of Oddi is important for efficient upper gastrointestinal tract function, I hope to further elucidate the roles these circuits play in gastrointestinal physiology.

Beginning in the fall, I also hope to establish a related research project at the College, providing research opportunities for undergraduate biology majors.

SUSTAINABLE DEVELOPMENT: THE SEARCH FOR ECONOMIC, SOCIAL, AND ENVIRONMENTAL HEALTH

Helene S. Fine, Associate Professor of Management



The subject of my research is sustainable development, recently defined by the World Commission on Environment and Development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs." In recent years, activists on behalf of environmental preservation, economic justice, and democratic control of corporations have found common cause in the move toward sustainability. A sustainable society must be economically viable, environmentally sound, socially just, and locally controlled.

The search for indicators of sustainability stems from the belief that existing measures do not capture the true state of social, economic, and environmental health. For example, the most common of the measures currently used, the Gross Domestic Product (GDP), is a measure of all goods and services sold within a country. Another measure, productivity, compares goods and services sold to resources used to produce them (i.e., outputs/inputs). Other measures include median household income and, finally, levels of employment. When each is increasing, we pronounce the economy robust and, therefore, the society healthy!

What these measures fail to do, however, is factor in issues of social justice, economic equity, or environmental sensitivity. Increased spending on prisons or on oil spill clean-ups contributes as much to the GDP as spending on education and healthcare, the development of wind-based energy technologies, or food relief to the victims of famine. The GNP is indifferent to the nature of goods and services sold.

While productivity figures could tell us how much non-renewable energy is consumed in the production of goods and services, they generally don't. More often than not the figures we get are for labor productivity. As a result, they often signal the displacement of workers to lower levels of employment.

The quality of employment and the equitable distribution of wealth are not issues in standard economic measures. Serving burgers at McDonalds is as good as semi-skilled work in a metal fabricating shop. One hundred thousand people earning \$40,000 each is the same as 100,000 people earning \$30,000 each and one person earning \$1 billion!

Realizing that growth alone does not guarantee a healthy society, activists in communities the world over have begun to create alternative indicators. These are relevant either to the economy as a whole, to specific regions, or to individual organizations. One such alternative is the Genuine Progress Indicator (GPI). In the belief that household and volunteer work contribute to the quality of life, the GPI assigns positive values to these but subtracts for factors that diminish that quality. Some of the latter include resource depletion and habitat degradation, loss of leisure time, the costs of crime, and any growing inequities in the distribution of wealth. Regional Sustainability Indicators factor in such negative values as water consumption and traffic congestion, while positive indicators are generated by volunteer activity and voter turnout.

Efforts to judge the sustainability of individual organizations have also blossomed in the past year. Europeans, alarmed at the degradation of their environment, are demanding "green" products in the marketplace. Although a meaningful "green label" has yet to arrive, the ISO 14,000 series certification might serve that need temporarily. ISO 14,000 is a set of international standards for environmental sensitivity and social accountability that goes beyond the bottom line. Few in this region know of its existence or the impact that it will have on the marketplace. Before long, many consumers in Europe will refuse to buy products from companies that do not have this certification.

In order to further our ability both to gauge the performances of individual organizations and to compare them with one another, I have created a sustainability scale. Using the scale, an organization would receive a score based on a number of factors, including economic viability, environmental soundness in products and processes and commitment to the employees' education and training. Each factor would be weighted to reflect its importance. The same scale could be used to rate sustainability at the regional, national and global levels.

I have been invited to present my work at the World Congress on Human Coexistence in a Responsible World at the Dawn of the Third Millennium, to be held in Montreal this July.